

Serial No. 10/699,460
February 10, 2004
Page 2 of 12

AMENDMENTS TO THE SPECIFICATION:

Please REPLACE paragraph no. 188 bridging pages 79 and 80 of the Specification with the following amended paragraph:

[0188] Next, as illustrated in FIG. 1D, the substrate **101** is ion-doped with phosphorus **110** from above the substrate **101** and across the entire surface thereof. The ion doping was performed by using phosphine (PH₃) as the doping gas with an acceleration voltage of about 5 kV to about 15 kV, and a dose of about $5 \times 10^{15} \text{ cm}^{-2}$ to about $2 \times 10^{16} \text{ cm}^{-2}$ (e.g., about $1 \times 10^{16} \text{ cm}^{-2}$). Through this step, the exposed regions of the crystalline silicon film **104b** are doped with phosphorus **110**, thereby forming phosphorus-doped regions **111**. In the region **111**, the crystalline structure is destroyed to some extent by the ion doping step, thus amorphizing the region **111**. The masked regions of the crystalline silicon film **104b** are not doped with phosphorus **110**, whereby the crystalline structure thereof is not destroyed.

Please REPLACE paragraph no. 194 bridging pages 83 and 84 of the Specification with the following amended paragraph:

[0194] Then, as illustrated in FIG. 1H, an n-type impurity (phosphorus) **123** is implanted into the active region by an ion doping method using the gate electrode **117** and the surrounding oxide film **118** as a mask. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is preferably set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is preferably set to about $1 \times 10^{15} \text{ cm}^{-2}$ to about $8 \times 10^{15} \text{ cm}^{-2}$ (e.g., about $2 \times 10^{15} \text{ cm}^{-2}$). The region **124** that is doped with an impurity later becomes the source/drain region of the TFT, and a region **120** that is masked with the gate electrode **117** and the surrounding oxide film **118** and is not doped with an impurity later becomes the channel region of the TFT. Then, the substrate is annealed by being

Serial No. 10/699,460
February 10, 2004
Page 3 of 12

irradiated with laser light from above the substrate so as to activate the implanted n-type impurity while improving the crystallinity of portions where the crystallinity has been deteriorated through the impurity introducing step as described above. In this step, XeCl excimer laser (wavelength: about 308 nm, pulse width: about 40 nsec) was used with an energy density of about 150 mJ/cm² to about 400 mJ/cm² (preferably about 200 mJ/cm² to about 250 mJ/cm²). The channel region 120 is masked with the overlying gate electrode 117 and is not irradiated with laser light. The sheet resistance of the obtained n-type impurity (phosphorus) region 124 was about 200 Ω/square to about 500 Ω/square.

Please REPLACE paragraph no. 213 on page 96 of the Specification with the following amended paragraph:

[0213] Then, as illustrated in FIG. 2G, a low concentration of an impurity (phosphorus) 219 is implanted into the active region by an ion doping method using the gate electrode 217 as a mask. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is preferably set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is preferably set to about 1×10^{12} to about 1×10^{14} to 1×10^{15} cm⁻² (e.g., about 8×10^{12} to 8×10^{14} cm⁻²). Through this step, a low concentration of phosphorus 219 is implanted into a region 221 of the island-shaped silicon film 215 that is not covered with the gate electrode 217, and a region 220 that is masked with the gate electrode 217 and is not doped with phosphorus 219 will later be the channel region of the TFT.

Please REPLACE paragraph no. 214 bridging pages 96 and 97 of the Specification with the following amended paragraph:

[0214] Then, a photoresist doping mask 222 with a thick side wall is provided so as to cover the gate electrode 217, as illustrated in FIG. 2H. Then, a high concentration of

Serial No. 10/699,460
February 10, 2004
Page 4 of 12

an impurity (phosphorus) 223 is implanted into the active region by an ion doping method using the resist mask 222. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is preferably set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is preferably set to about 1×10^{15} to about 8×10^{15} 8×10^4 cm⁻² (e.g., about 2×10^{15} 2×10^4 cm⁻²). The region doped with a high concentration of the impurity (phosphorus) 223 will later be a source/drain region 224 of the TFT. In the active region 215, the region that is covered with the resist mask 222 and is not doped with a high concentration of phosphorus 223 is left as a region doped with a low concentration of phosphorus, which forms the LDD (Lightly Doped Drain) region 221. By forming the LDD region 221 as described above, the electric field localization at the junction between the channel region and the source/drain region is reduced, whereby it is possible to reduce the TFT off-state leak current and to suppress the deterioration due to hot carriers, thus improving the reliability of the TFT.

Please REPLACE paragraph no. 230 bridging pages 106 and 107 of the Specification with the following amended paragraph:

[0230] Then, as illustrated in FIG. 4A, an n-type impurity (phosphorus) 323 is implanted into the active region by an ion doping method using the gate electrodes 317n and 317p as masks. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is set to about 1×10^{15} cm⁻² to about 1×10^{16} 1×10^4 cm⁻² (e.g., about 6×10^{15} 6×10^4 cm⁻²). In the active region 315n of the n-channel TFT, a region 324 doped with a high concentration of phosphorus 323 will later be the source/drain region of the n-channel TFT, and the region that is masked with the gate electrode 317n and is not doped with phosphorus 323 will later be a channel region 320n of the n-channel TFT. The active region 315p of the p-channel TFT is also doped with phosphorus. This is done so that a high concentration of phosphorus implanted into these regions can be used as a gett ring

Serial No. 10/699,460
February 10, 2004
Page 5 of 12

element for gettering the catalyst element into the source and drain regions in the subsequent second heat treatment.

Please REPLACE paragraph no. 231 bridging pages 107 and 108 of the Specification with the following amended paragraph:

[0231] Then, as illustrated in FIG. 4B, a photoresist doping mask 325 is provided so as to cover the active region 315n of the n-channel TFT. Then, an impurity giving p-type conductivity (boron) 326 is implanted into the active region 315p of the p-channel TFT by an ion doping method using the resist mask 325 and the gate electrode 317p of the p-channel TFT as masks. Diborane (B₂H₆) is used as the doping gas, the acceleration voltage is set to about 40 kV to about 80 kV (e.g., 65 kV), and the dose is set to about 5×10^{15} to about $2 \times 10^{16} \text{ cm}^{-2}$ (e.g., about $1 \times 10^{16} \text{ cm}^{-2}$). The polarity of a region 327 that is doped with a high concentration of boron 326 is inverted from n type to p type through a so-called "counter doping" process, and will later be the source/drain region of the p-channel TFT, whereas the region that is masked with the gate electrode 317p and is not doped with an impurity will later be a channel region 320p of the p-channel TFT. In this step, since the active region 315n of the n-channel TFT is covered entirely with a mask 325, the active region 315n is not at all doped with boron 326.

Please REPLACE paragraph no. 252 bridging pages 118 and 119 of the Specification with the following amended paragraph:

[0252] Then, a low concentration of an impurity (phosphorus) 419 is implanted into the active region by an ion doping method using the gate electrodes 417n and 417p as masks. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is set to about 1×10^{12} to

Serial No. 10/699,460
February 10, 2004
Page 6 of 12

about 1×10^{14} to 1×10^{15} cm $^{-2}$ (e.g., about 2×10^{13} to 2×10^{14} cm $^{-2}$). Through this step, regions of the island-shaped silicon films **415n** and **415p** that are not covered with the gate electrodes **417n** and **417p** become regions **421** doped with a low concentration of phosphorus **419**, and regions that are masked with the gate electrodes **417n** and **417p** and are not doped with the impurity **419** will later be channel regions **420n** and **420p** of the n-channel TFT and the p-channel TFT, respectively. This state is shown in FIG. 5F.

Please REPLACE paragraph no. 253 bridging pages 119 and 120 of the Specification with the following amended paragraph:

[0253] Then, as illustrated in FIG. 6A, photoresist doping masks **422** are provided. For the n-channel TFT, the photoresist doping mask **422** with a thick side wall is provided so as to cover the gate electrode **417n**, as illustrated in FIG. 6A. For the p-channel TFT, the photoresist doping mask **422** with a thicker side wall is provided so as to cover the gate electrode **417p** with only a peripheral portion of the active region **415p** being exposed. Then, a high concentration of an impurity (phosphorus) **423** is implanted into the active region by an ion doping method using the resist masks **422**. Phosphine (PH₃) is used as the doping gas, the acceleration voltage is set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose is set to about 2×10^{15} cm $^{-2}$ to about 1×10^{16} to 1×10^{17} cm $^{-2}$ (e.g., about 5×10^{15} to 5×10^{16} cm $^{-2}$). For the n-channel TFT, a region **424** doped with a high concentration of the impurity (phosphorus) **423** will later be the source/drain region of the n-channel TFT. The region of the active region **415n** that is covered with the resist mask **422** and is not doped with a high concentration of phosphorus **423** is left as a region doped with a low concentration of phosphorus, which forms the LDD (Lightly Doped Drain) region **421**. For the p-channel TFT, the region **424** doped with a high concentration of the impurity (phosphorus) **423** will later form the gettering region of the p-channel TFT. The concentration of the n-type impurity element (phosphorus) **423** in the region **424** is about 1×10^{19} to about 1×10^{21} /cm 3 . Moreover, the

Serial No. 10/699,460
February 10, 2004
Page 7 of 12

concentration of the n-type impurity element (phosphorus) 419 in the LDD region 421 of the n-channel TFT is in the range of about 1×10^{17} to about $1 \times 10^{20}/\text{cm}^3$, within which the region functions as an LDD region.

Please REPLACE paragraph no. 254 bridging pages 120 and 121 of the Specification with the following amended paragraph:

[0254] Then, after the resist mask 422 is removed, a photoresist doping mask 425 is provided in the active region 415n of the n-channel TFT, as illustrated in FIG. 6B. The photoresist doping mask 425 with a thick side wall is provided so as to cover the LDD region 421 with only a peripheral portion of the active region 415n being exposed, as illustrated in FIG. 6B. At this time, no mask is provided for the p-channel TFT, whereby the TFT is entirely exposed. Then, an impurity giving p-type conductivity (boron) 426 is implanted into the active regions by an ion doping method using the resist mask 425 and the gate electrode 417p of the p-channel TFT as masks. Diborane (B_2H_6) is used as the doping gas, the acceleration voltage is set to about 40 kV to about 80 kV (e.g., 65 kV), and the dose is set to about $1 \times 10^{15} \text{ cm}^{-2}$ to about 1×10^{16} $\text{ } 1 \times 10^4 \text{ cm}^{-2}$ (e.g., about 7×10^{15} $\text{ } 7 \times 10^4 \text{ cm}^{-2}$). For the n-channel TFT, a region 428n doped with a high concentration of boron 426 will later function as the gettering region of the n-channel TFT. The region of the active region 415p of the p-channel TFT other than the channel region 420p under the gate electrode 417p, which has been doped with a low concentration of n-type impurity (phosphorus) 419 in the previous step, is doped with a high concentration of boron 426, whereby the conductivity type thereof is inverted from n type to p type and the region will later be a source/drain region 427 of the p-channel TFT. Moreover, the region 424, which has been doped with a high concentration of phosphorus 423, is doped with an even higher concentration of boron 426, thereby forming a gettering region 428p of the p-channel TFT. The concentration of the p-type impurity element (boron) 426 in the region 427 and the regions 428n and 428p is

Serial No. 10/699,460

February 10, 2004

Page 8 of 12

preferably about 1.5×10^{19} to about $3 \times 10^{21}/\text{cm}^3$. The concentration is about 1 to 2 times that of the n-type impurity element (phosphorus). The gettering region **428n** of the n-channel TFT and the gettering region **428p** of the p-channel TFT are regions that have been doped with phosphorus **423** (in the previous step) and with boron **426** (in the current step).

Please REPLACE paragraph no. 272 bridging pages 130 and 131 of the Specification with the following amended paragraph:

[0272] Then, a low concentration of n-type impurity (phosphorus) **519** is implanted into the active region by an ion doping method using the gate electrodes **517n** and **517p** as masks. In the present preferred embodiment, phosphine (PH_3) was used as the doping gas, the acceleration voltage was set to about 80 kV, and the dose was set to about $2 \times 10^{13} \text{--} 2 \times 10^{14} \text{ cm}^{-2}$. Through this step, regions of the island-shaped silicon films **515n** and **515p** that are not covered with the gate electrodes **517n** and **517p** become regions **521** doped with a low concentration of phosphorus **519**, and regions that are masked with the gate electrodes **517n** and **517p** and are not doped with the impurity **519** will later be channel regions **520n** and **520p** of the n-channel TFT and the p-channel TFT, respectively. This state is shown in FIG. 7E.

Please REPLACE paragraph no. 273 bridging pages 131 and 132 of the Specification with the following amended paragraph:

[0273] Then, as illustrated in FIG. 7F, photoresist doping masks **522** are provided. In the active region **515n** of the n-channel TFT, the photoresist doping masks **522** with a thick side wall is provided so as to cover the gate electrode **517n**, as illustrated in FIG. 7F. In the active region **515p** of the p-channel TFT, the photoresist doping masks **522** with an even thicker side wall is provided so as to cover the entire active region, as

Serial No. 10/699,460
February 10, 2004
Page 9 of 12

illustrated in FIG. 7F. Then, a high concentration of an impurity (phosphorus) 523 is implanted into the active regions by an ion doping method using the resist masks 522. In the present preferred embodiment, phosphine (PH₃) was used as the doping gas, the acceleration voltage was set to about 80 kV, and the dose was set to about $5 \times 10^{15} \text{ to } 5 \times 10^{16} \text{ cm}^{-2}$. For the n-channel TFT, a region 524 doped with a high concentration (about 1×10^{19} to about $1 \times 10^{21}/\text{cm}^3$) of phosphorus 523 will later be the source/drain region of the n-channel TFT. In the active region 515n, the region that is covered with the resist mask 522 and is not doped with a high concentration of phosphorus 523 is left as a region doped with a low concentration of phosphorus, which forms the LDD (Lightly Doped Drain) region 521. For the p-channel TFT, no phosphorus is implanted into the active region 515p.

Please REPLACE paragraph no. 274 on page 132 of the Specification with the following amended paragraph:

[0274] Then, after the resist masks 522 are removed, a photo-resist doping mask 525 is provided so as to entirely cover the active region 515n of the n-channel TFT, as illustrated in FIG. 8A. At this time, no mask is provided over the active region 515p of the p-channel TFT, whereby the TFT is entirely exposed. Then, an impurity giving p-type conductivity (boron) 526 is implanted into the active regions by an ion doping method using the resist mask 525 and the gate electrode 517p of the p-channel TFT as masks. Diborane (B₂H₆) was used as the doping gas, the acceleration voltage was set to about 65 kV, and the dose was set to about $7 \times 10^{18} \text{ to } 7 \times 10^{19} \text{ cm}^{-2}$. The region of the active region 515p of the p-channel TFT other than the channel region 520p under the gate electrode 517p, which has been doped with a low concentration of n-type impurity (phosphorus) 519 in the previous step, is doped with a high concentration of boron 526, whereby the conductivity type thereof is inverted from n type to p type and the region will later be a source/drain region 527 of the p-channel TFT.

Serial No. 10/699,460
February 10, 2004
Page 10 of 12

Please REPLACE paragraph no. 275 bridging pages 133 and 134 of the Specification with the following amended paragraph:

[0275] Then, after the resist mask **525** is removed, resist masks **529** are formed so as to cover the gate electrode **517n** of the n-channel TFT and the gate electrode **517p** of the p-channel TFT, as illustrated in FIG. 8B. With the masks **529**, a (peripheral) portion of each of the active regions **515n** and **515p** of the n-channel TFT and the p-channel TFT is exposed. Then, the substrate is ion-doped with a rare gas element (Ar in the present preferred embodiment) **530** from above the substrate across the entire surface of the substrate. Through this step, the rare gas element **530** is implanted into the exposed region of each TFT active region. Thus, gettering regions **528n** and **528p** are formed in peripheral portions of the active regions **515n** and **515p** of the n-channel TFT and the p-channel TFT, respectively. In this step, argon **530** was doped as follows. A 100% Ar gas was used as the doping gas, the acceleration voltage was set to about 60 kV to about 90 kV (e.g., about 80 kV), and the dose was set to about $1 \times 10^{15} \text{ cm}^{-2}$ to about $1 \times 10^{16} \text{ to } 1 \times 10^{17} \text{ cm}^{-2}$ (e.g., about $3 \times 10^{15} \text{ to } 3 \times 10^{17} \text{ cm}^{-2}$). The region covered with the masks **529** is not doped with the rare gas element. The rare gas element may be one or more rare gas element selected from Ar, Kr and Xe. Moreover, in this step, the concentration of the rare gas element in the gettering region **528** is controlled to be about 1×10^{19} to about 3×10^{21} atoms/cm³. Moreover, through this step, the crystallinity of the gettering region **528** is destroyed, thus amorphizing the gettering region **528**.